Investigation of Metal Oxides Passivation for CVD Graphene 40GHz Photodetectors

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Abstract

Graphene has gained increasing attention over the last decade, due to its outstanding properties that make it an excellent candidate for advanced applications in future electronics and photonics [1].
In particular, the potential of graphene for high-frequency optoelectronic applications is currently being extensively explored because of its ultra-high carrier mobility and absorption from the far infrared to the ultraviolet [2,3]. However, this application requires the fabrication of highly stable devices.

In this work, we aim at obtaining chemical vapor deposited (CVD) graphene based devices for radiofrequency (RF) optoelectronic applications. This target includes the necessity to develop a process that leads to a high control of graphene doping with long term stability. For that purpose, we investigated the impact of graphene passivation on the performances of stable graphene based photo-detectors under ambient conditions and over months. More specifically, we report the evaluation of metal oxides layers, namely Al_2O_3 and HfO_2, on key parameters of CVD graphene based devices, such as transistor characteristics or photodetectivity. Our passivation layers were deposited by atomic layer deposition (ALD) at the end of the fabrication process. The influence of an additional Al_2O_3 layer (obtained by ambient oxidation of thin Aluminum layer after graphene transfer) is also investigated to avoid parasitic graphene doping during the fabrication of photodetectors.
Our RF photodetector is a coplanar waveguide structure on well-adapted substrate and with a thick metallization in order to make it compatible up to 40GHz and to limit RF-losses.

Finally, we explore the link between graphene stable characteristics (Figure 1) and photoconductivity properties (Figure 2) in low and high frequency (up to 40GHz) domains. We show that electrical properties and photodetection measurements highlight the benefits of our optimized fabrication process. Besides, we demonstrate long term stable devices repeatedly tested for few months.

This work was funded through the European projects Grafol and Graphene Flagship.

References

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Figures

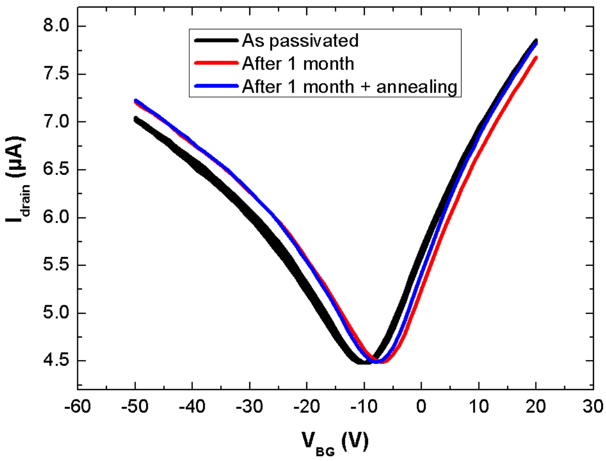

Figure 1. Transfer characteristics of a passivated graphene field effect transistor using HfO_2 measured under ambient conditions after 4 weeks storage and subsequent annealing.

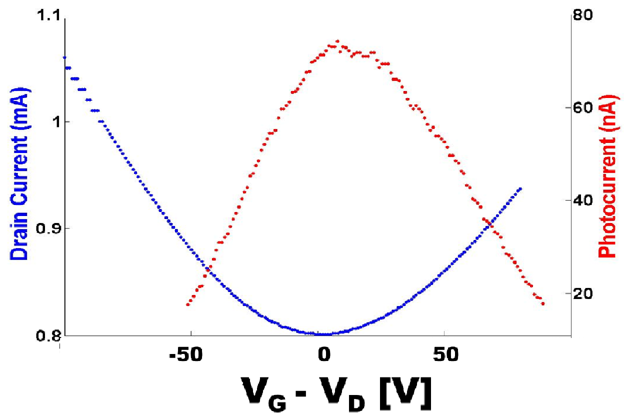

Figure 2. Photoresponse of a coplanar waveguide integrating a graphene film at 5GHz